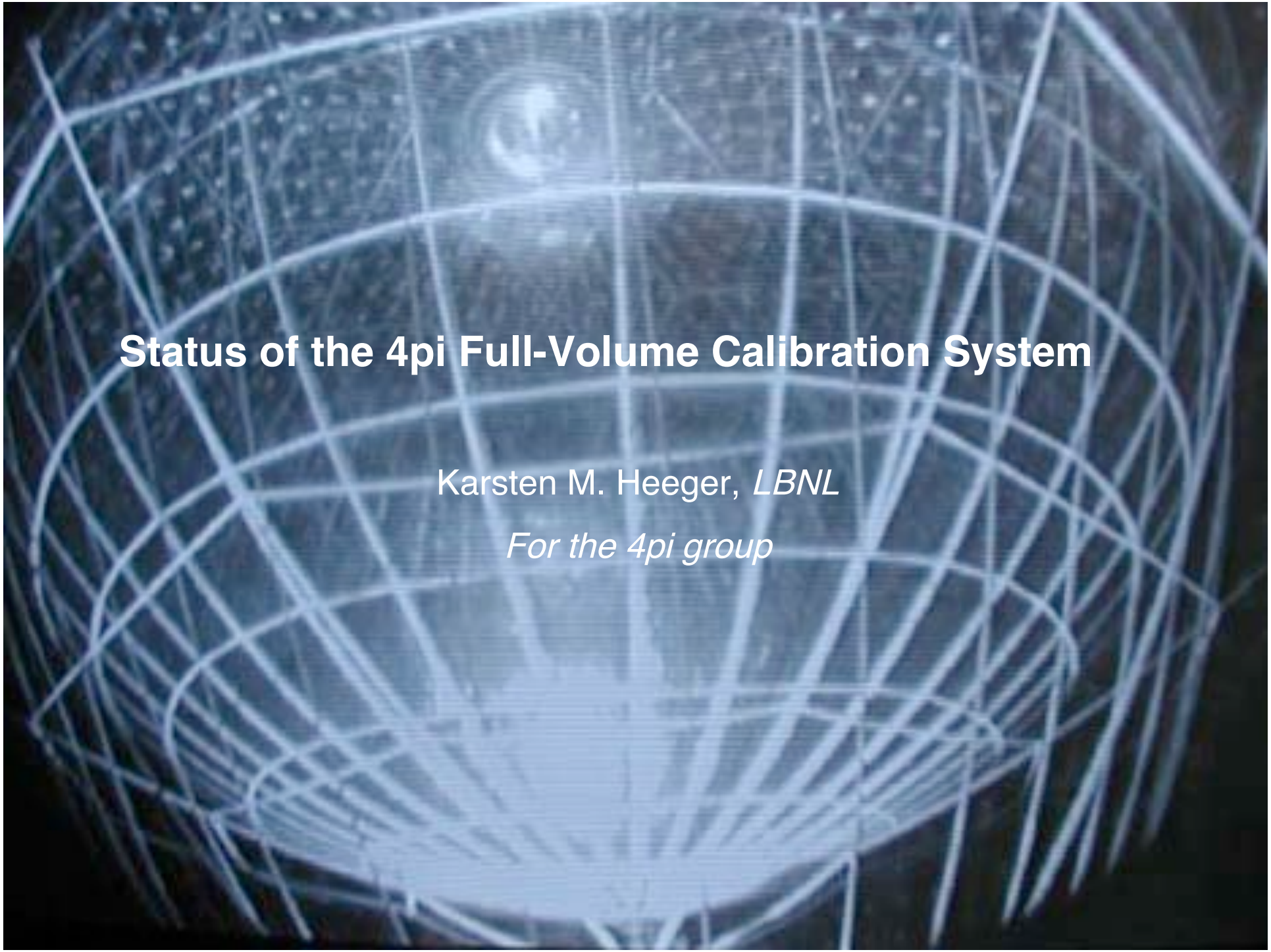
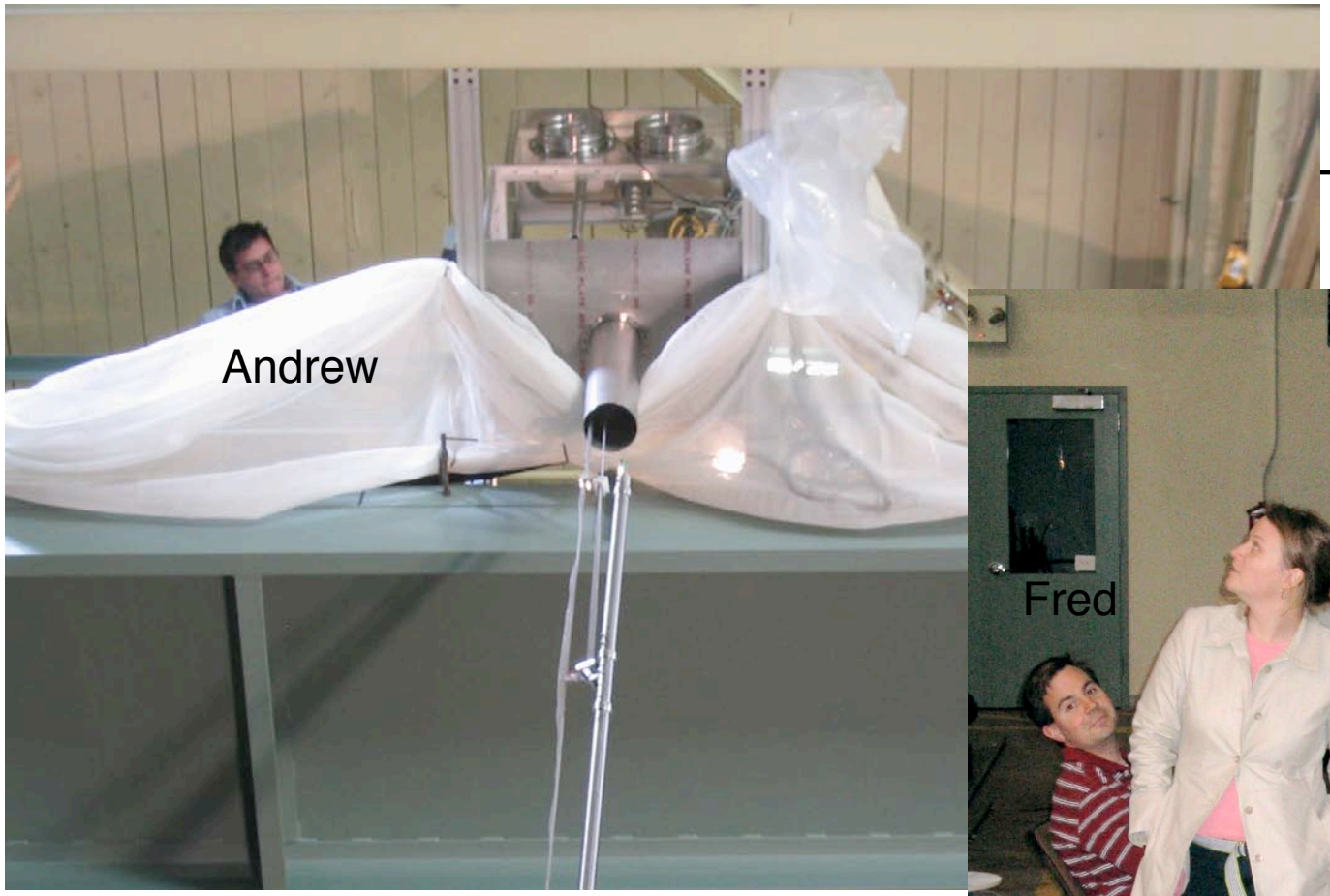


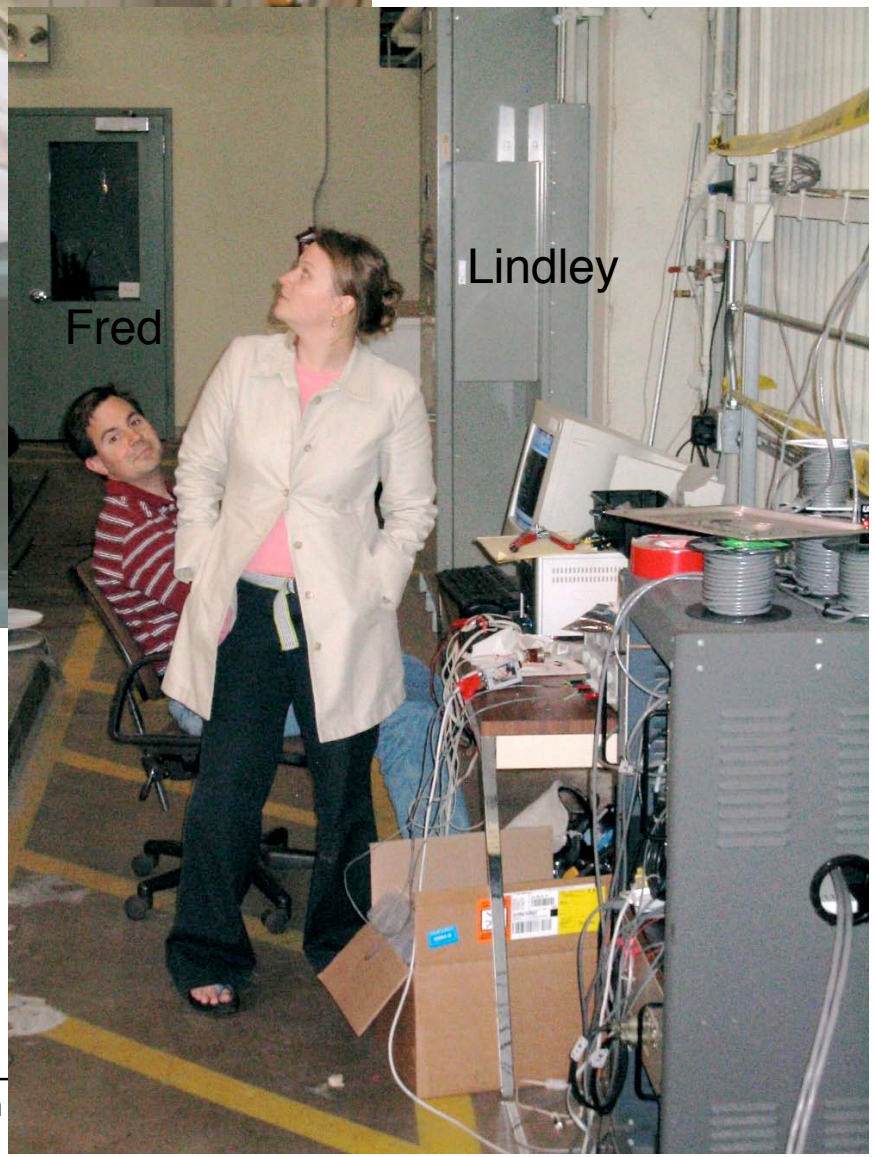
Status of the 4pi Full-Volume Calibration System

Karsten M. Heeger, *LBNL*

For the 4pi group

The 4pi Team

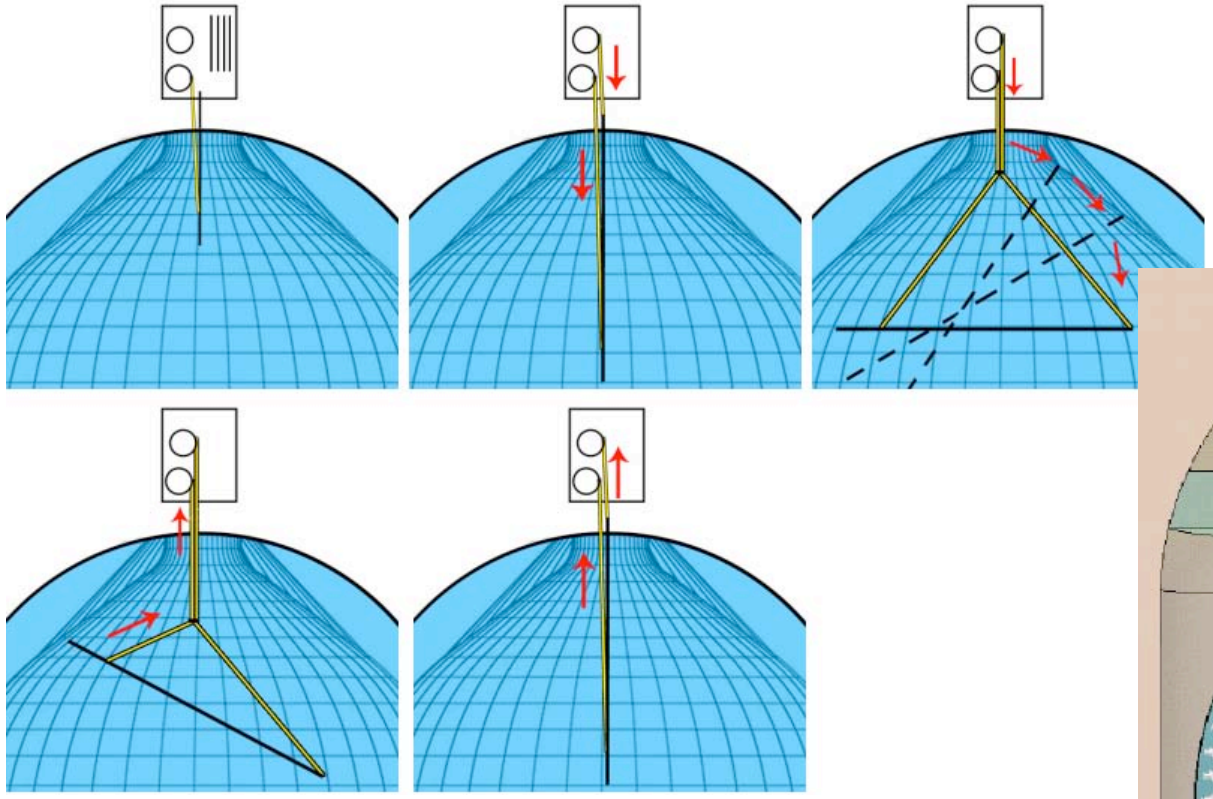




Don Syversrud, Joe Wallig
Bruce Berger, Patrick Decowski
Greg Keefer
Kengo Nakamura
Jerry Busenitz, Tim Classen
Herb Steiner, Karsten Heeger

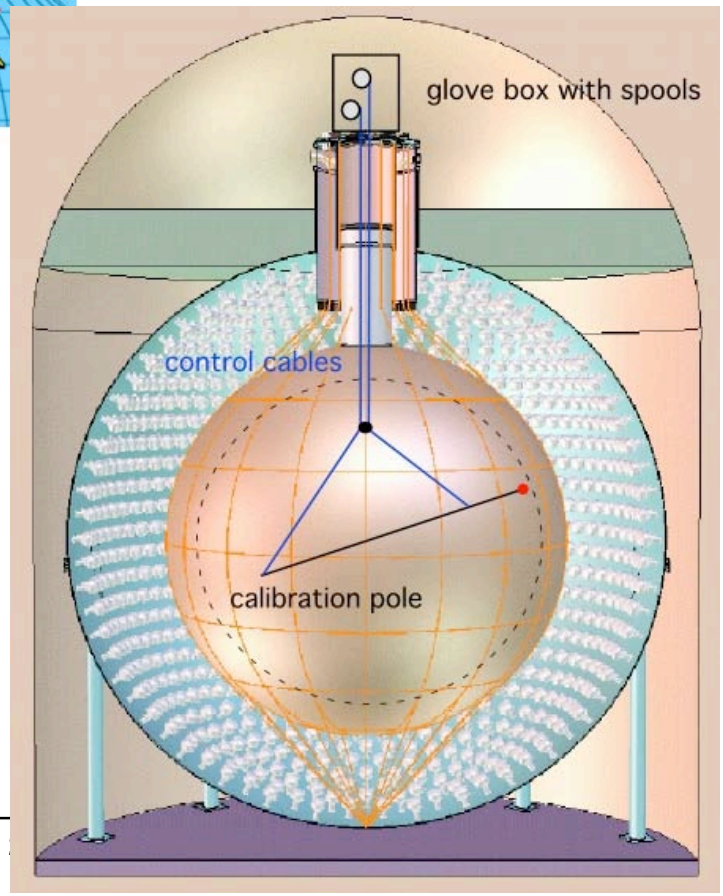
KamLAND Full-Volume Calibration

Calibration throughout entire detector volume



Fiducial volume: R < 5.5 m

ΔR_{FV} = 5 cm → ΔV= 2.7%
ΔR_{FV} = 2 cm → ΔV= 1.1%



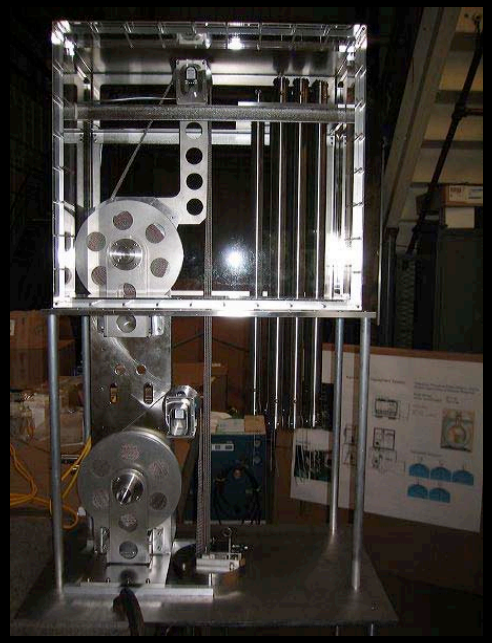
Position Dependence of Detector Response

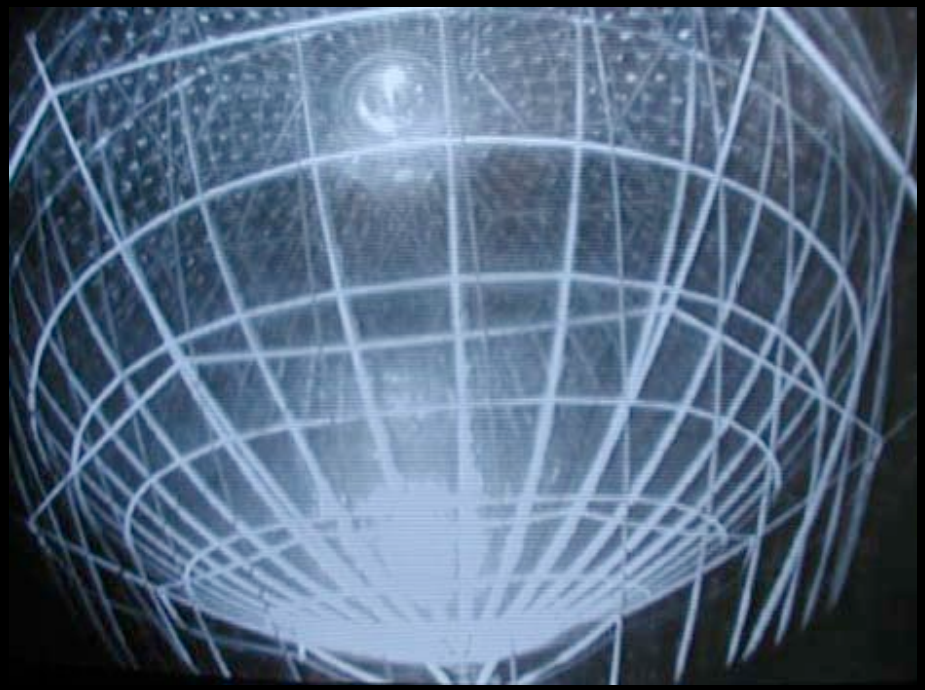
Event energy	$E(r,\theta,\phi)$
Vertex reconstruction	$R_{fit}(r,\theta,\phi)$

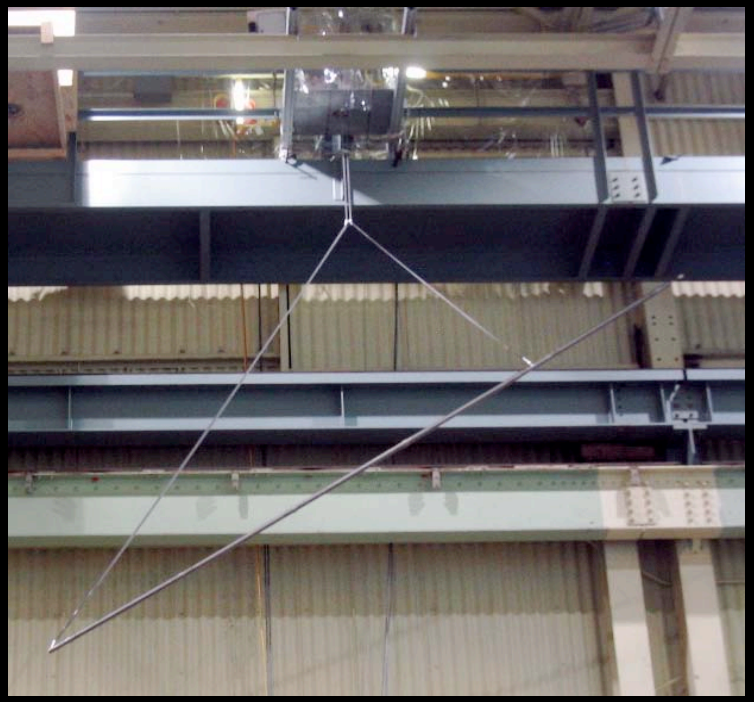
KamLAND Full-Volume Calibration System

Will reduce fiducial volume uncertainty:
4.7% → 1-1.5%.

Improves sensitivity to Δm^2_{12} (and θ_{12}).







Events Since Last Collaboration Meeting

Informal review of system by Marc Rosen in Nov 2004.

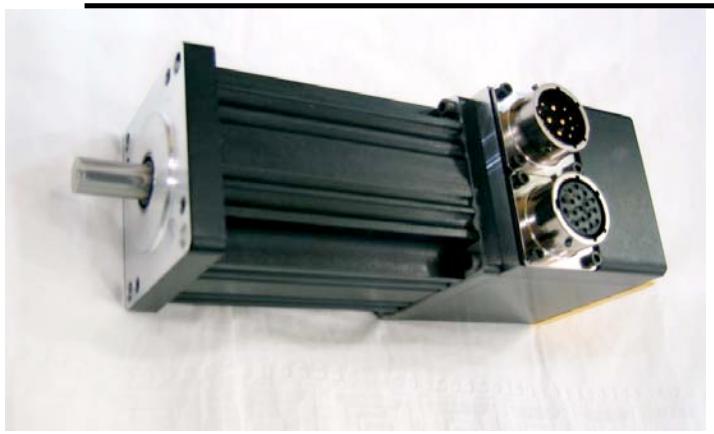
Continued testing and R&D. Optimized operation.

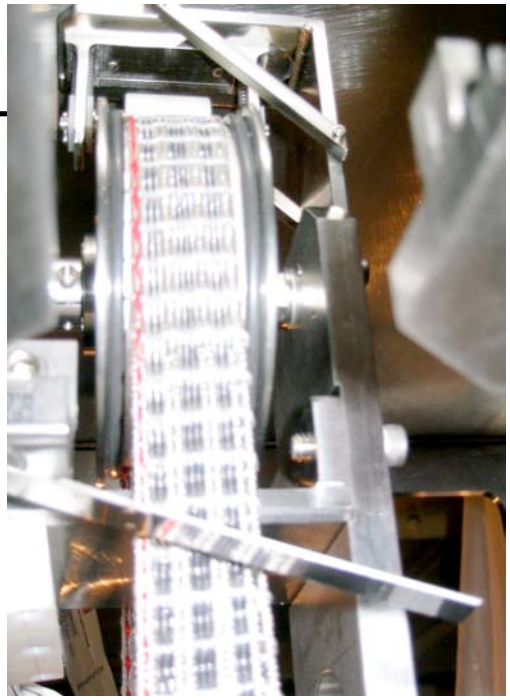
Replaced and re-worked several hardware parts.

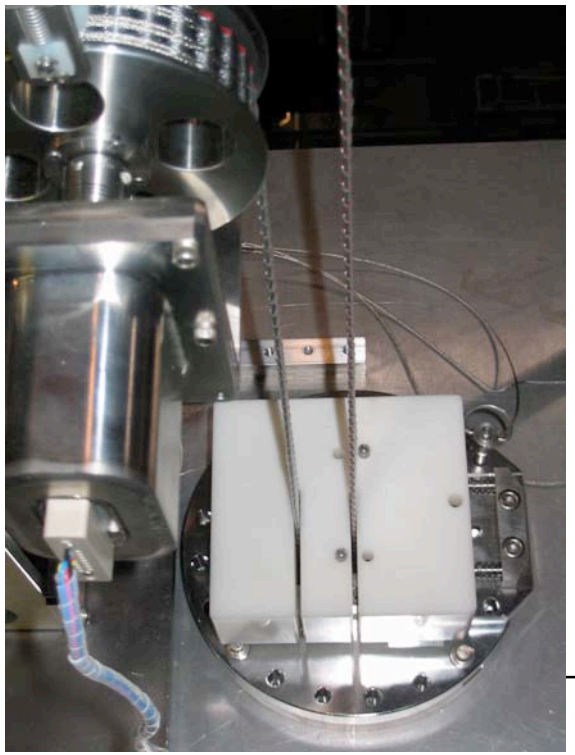
Studied recovery procedures in case of unusual circumstances.

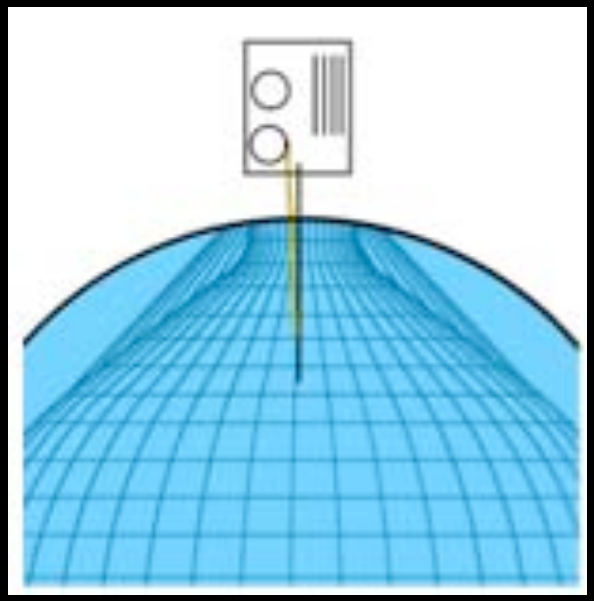
Test deployment of instrumentation unit in KamLAND in March 04.

Some of the Hardware Improvements

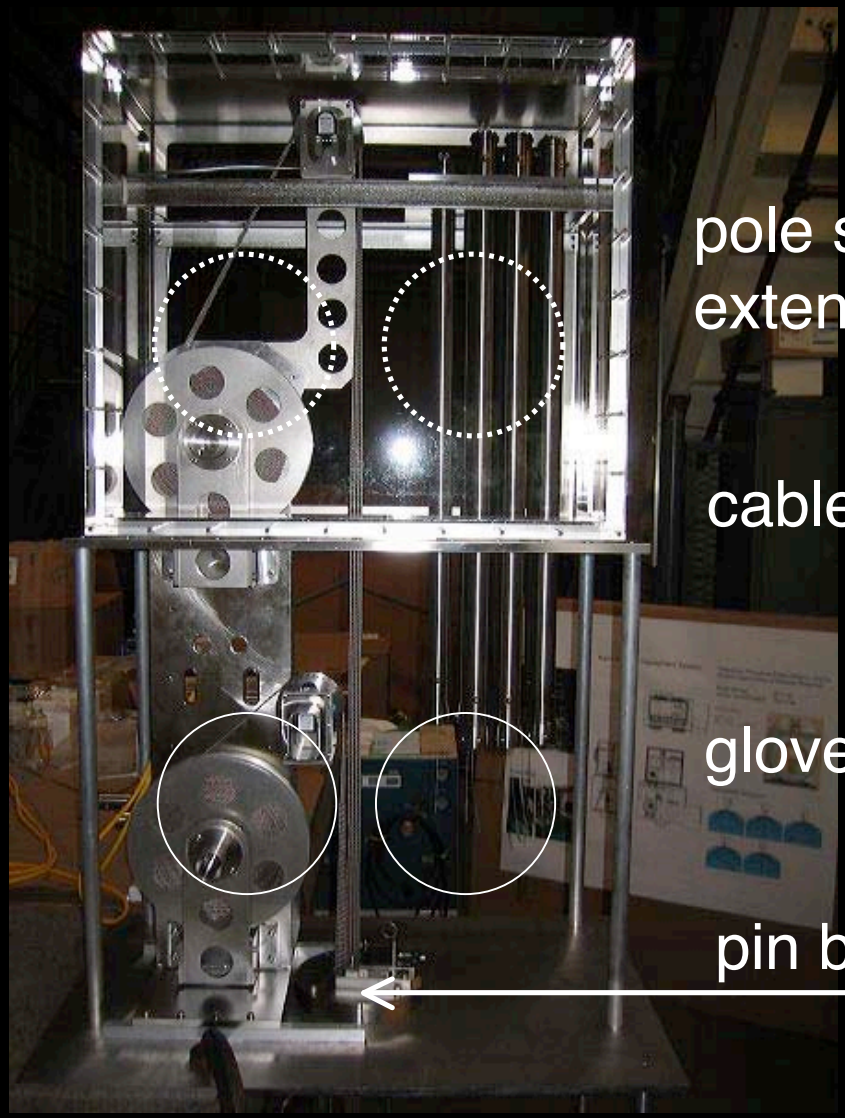








Assembly and Deployment

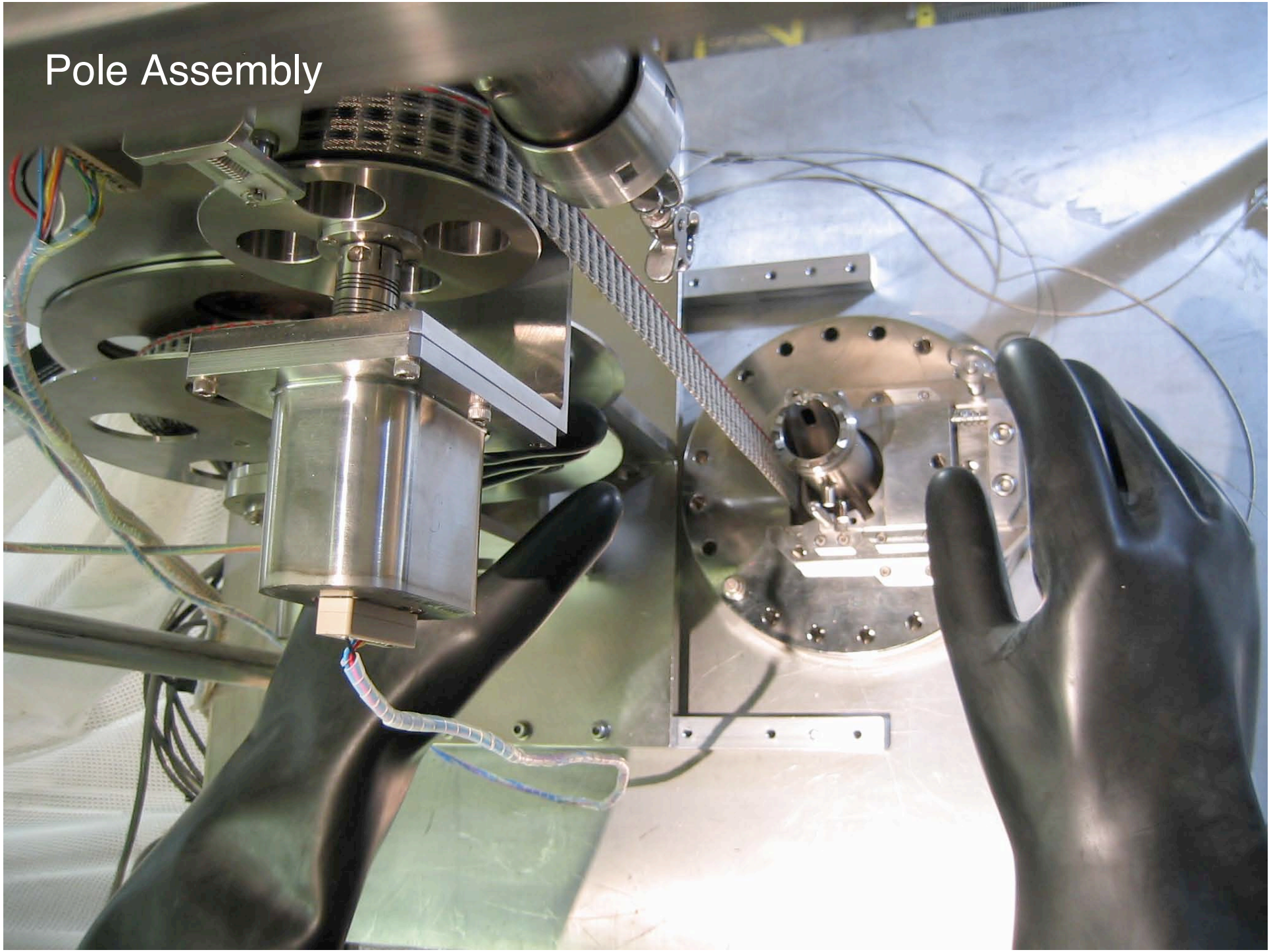


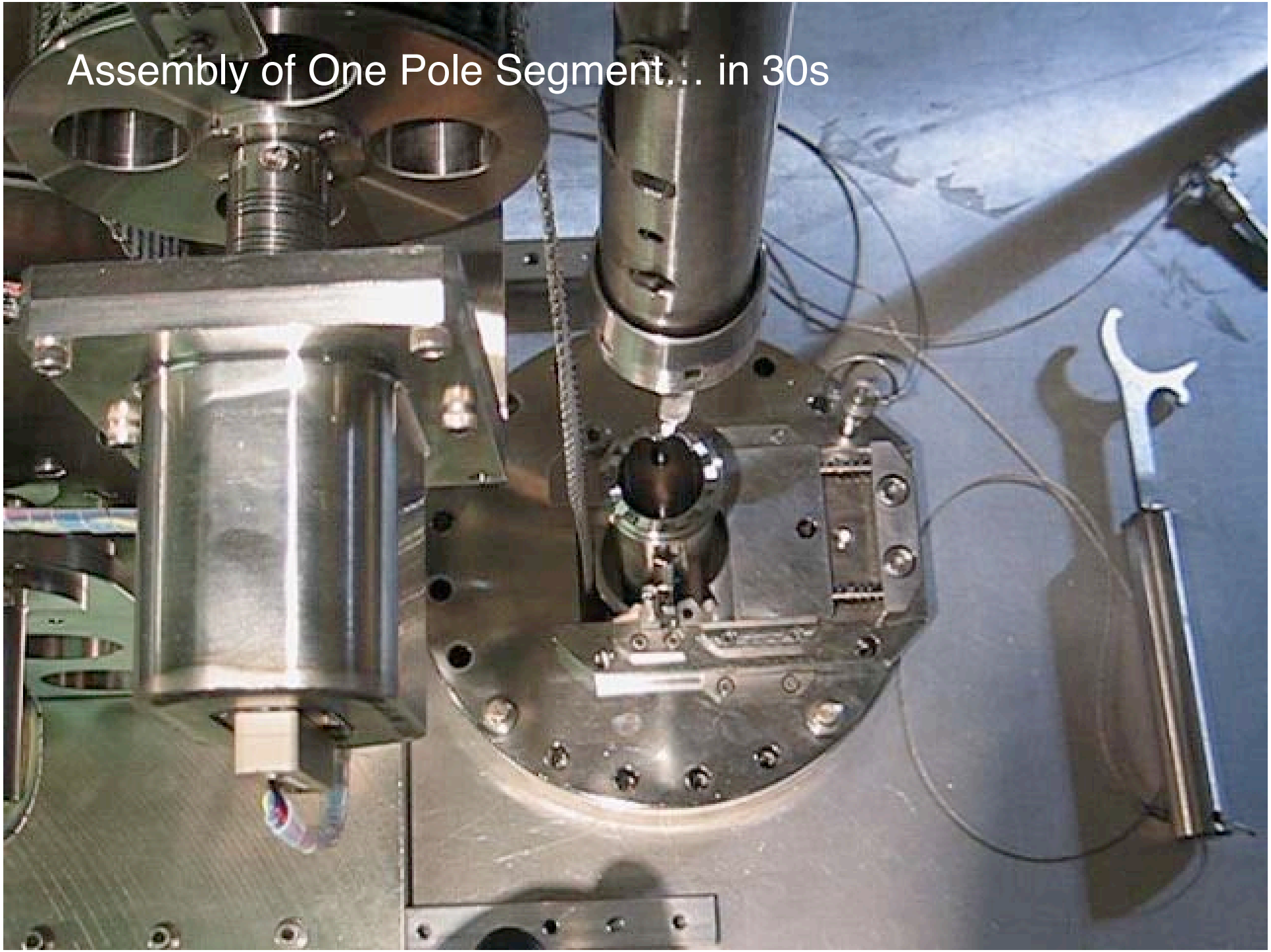
pole segments stored in glovebox extension

cable spools

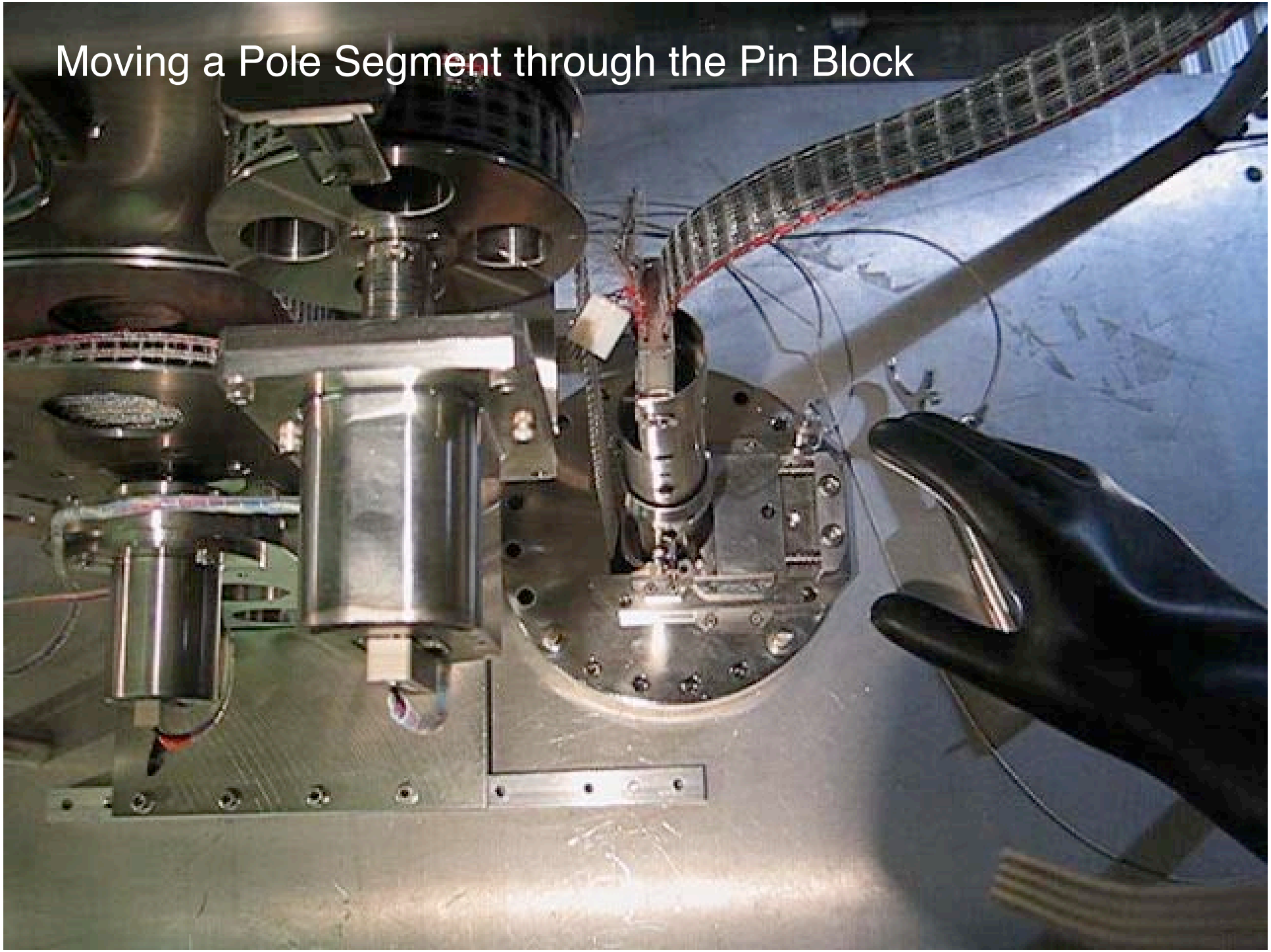
gloveports

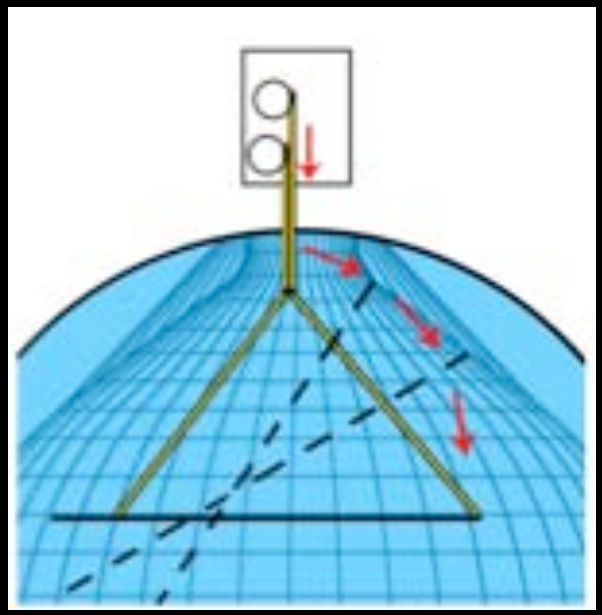
pin block


Pole Assembly


Assembly of One Pole Segment… in 30s

Moving a Pole Segment through the Pin Block

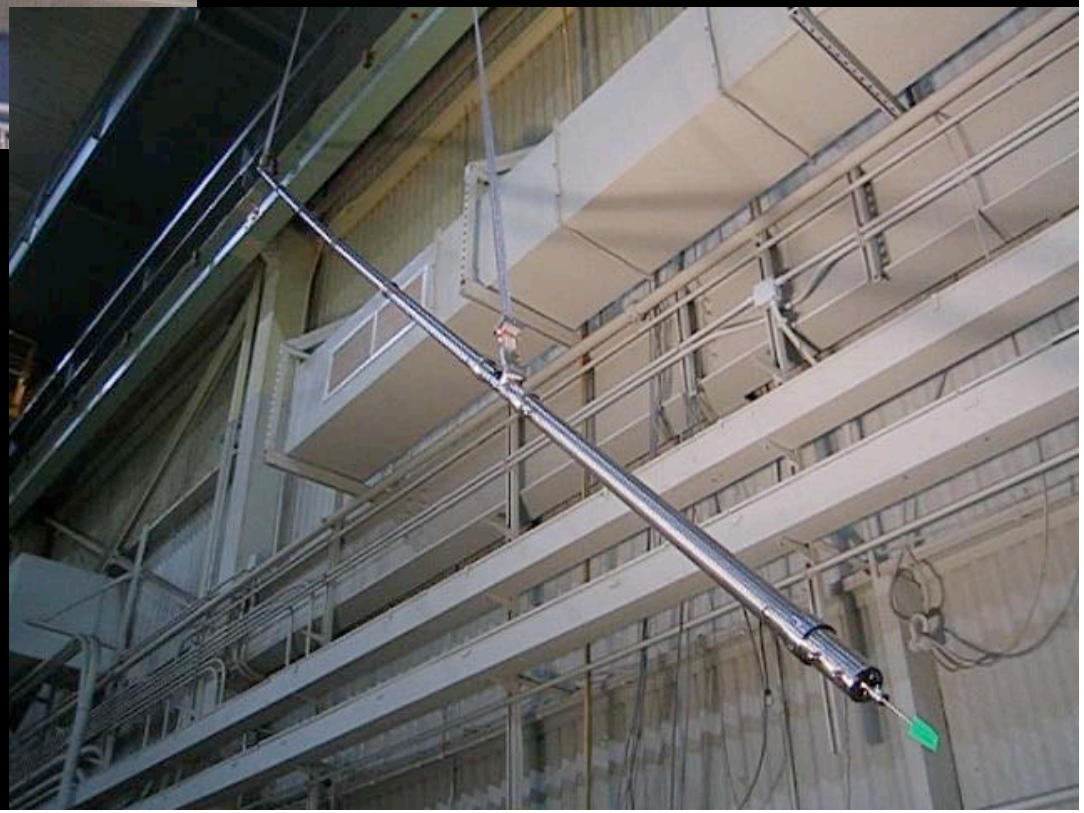


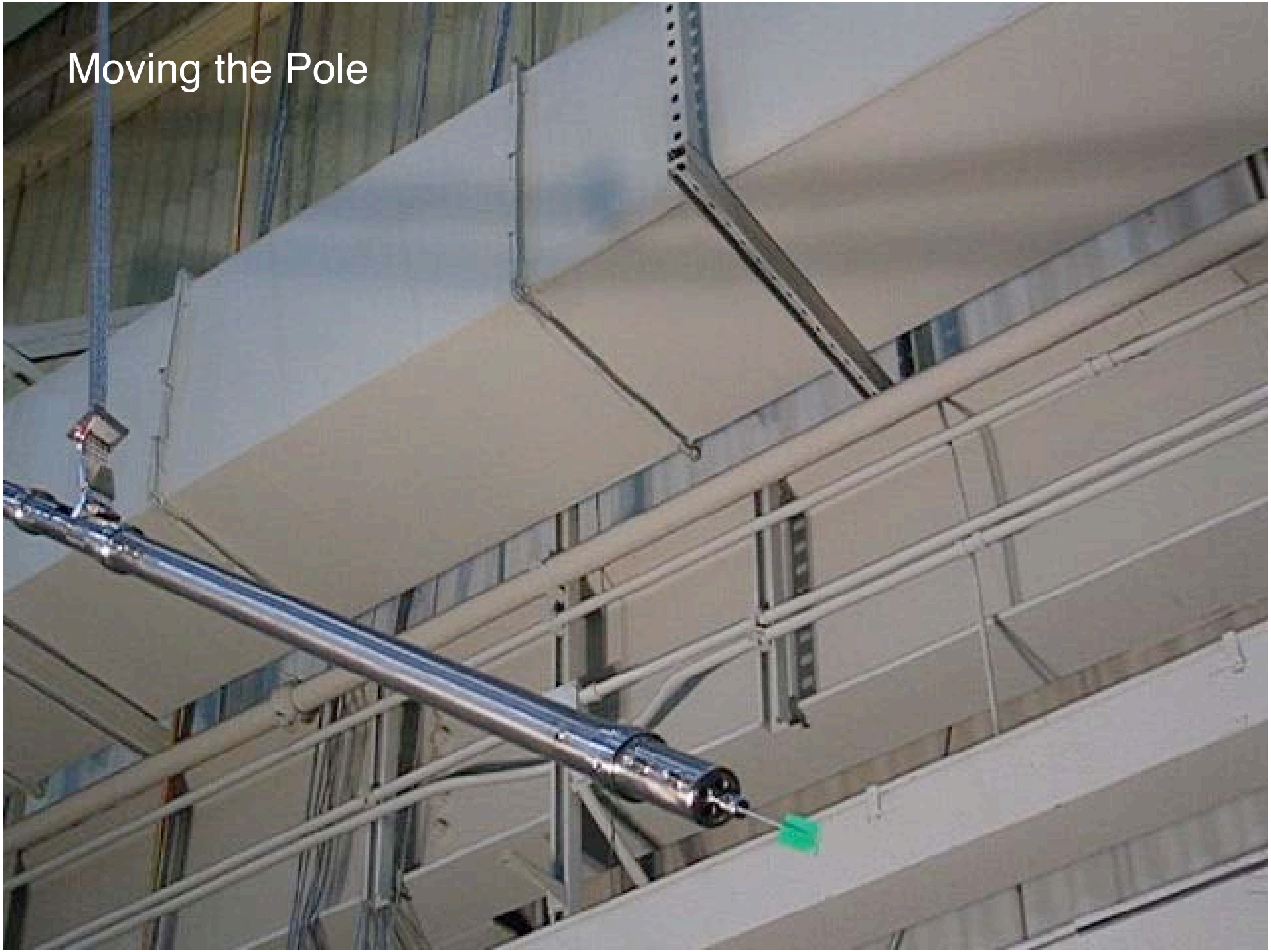


Moving into Position

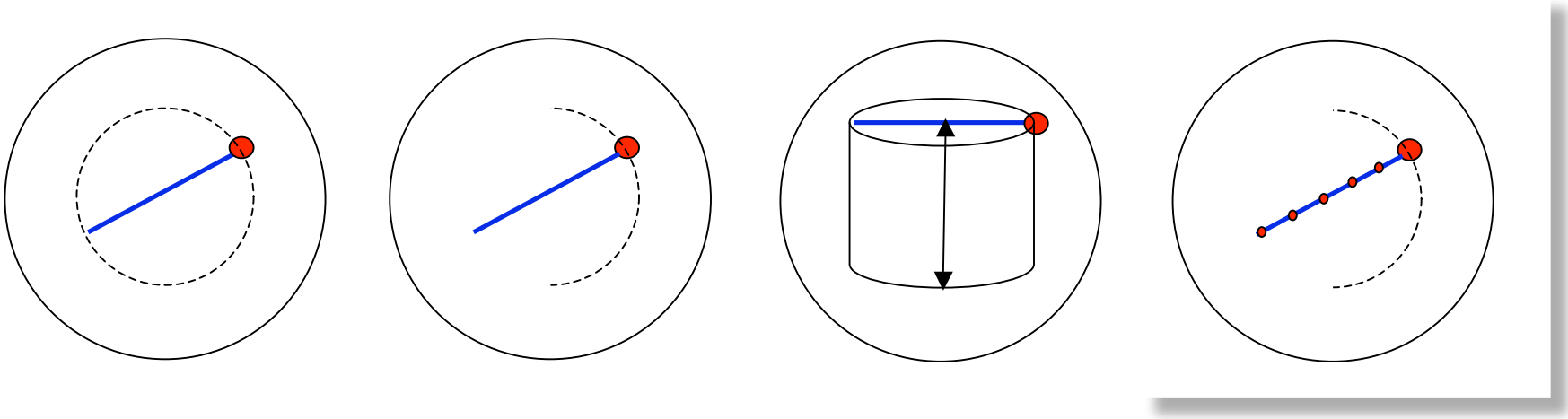
Moving the Pole in Position

Moving the Pole



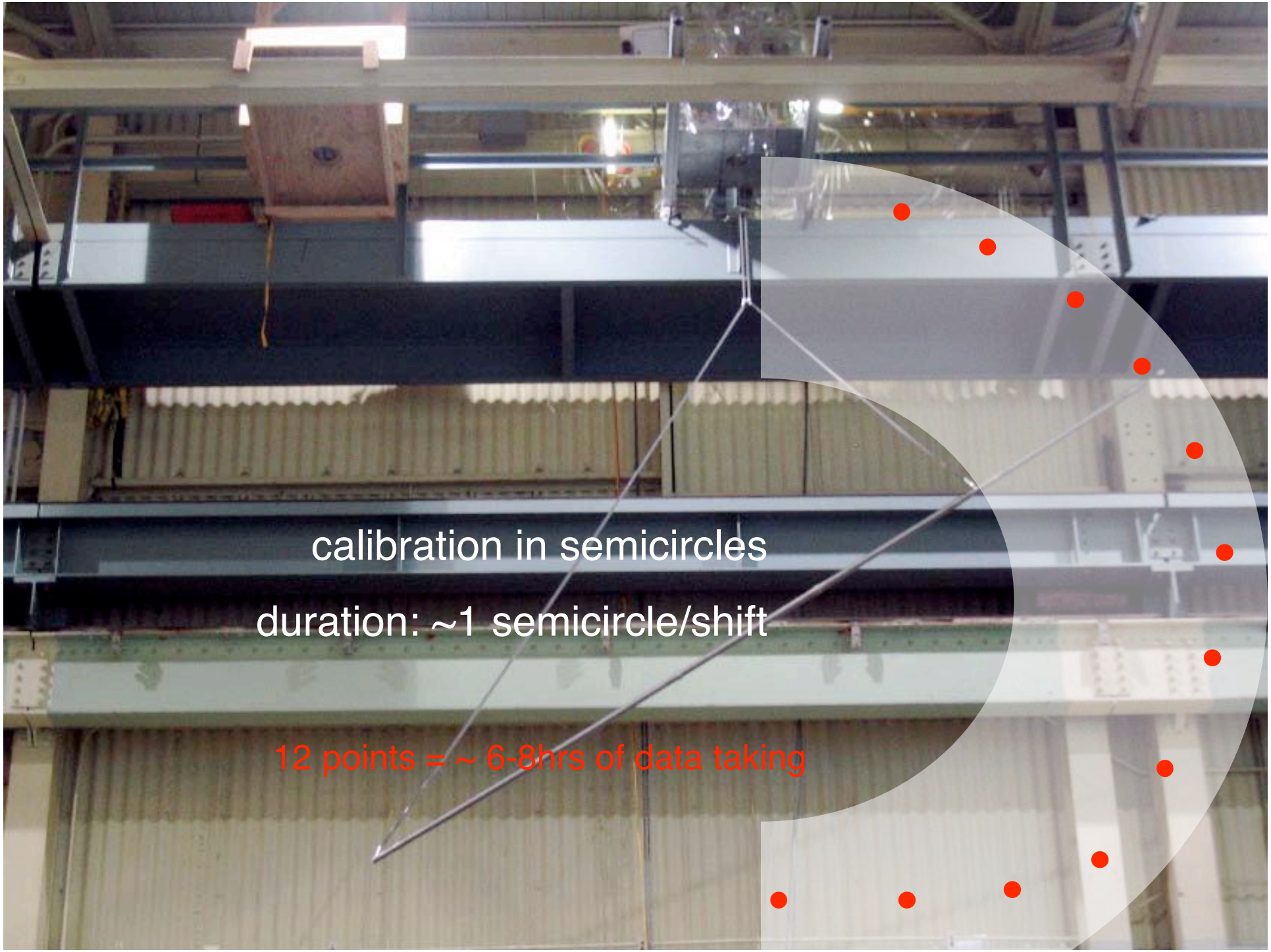

Moving the Pole

Possible Calibration and Deployment Scenarios

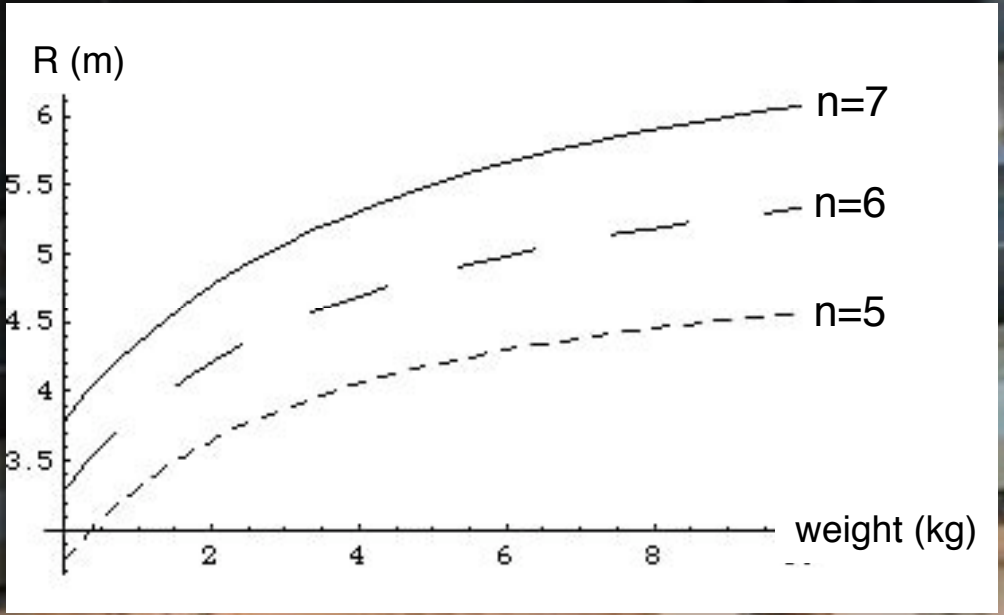


Optimized for ease and safety of operation

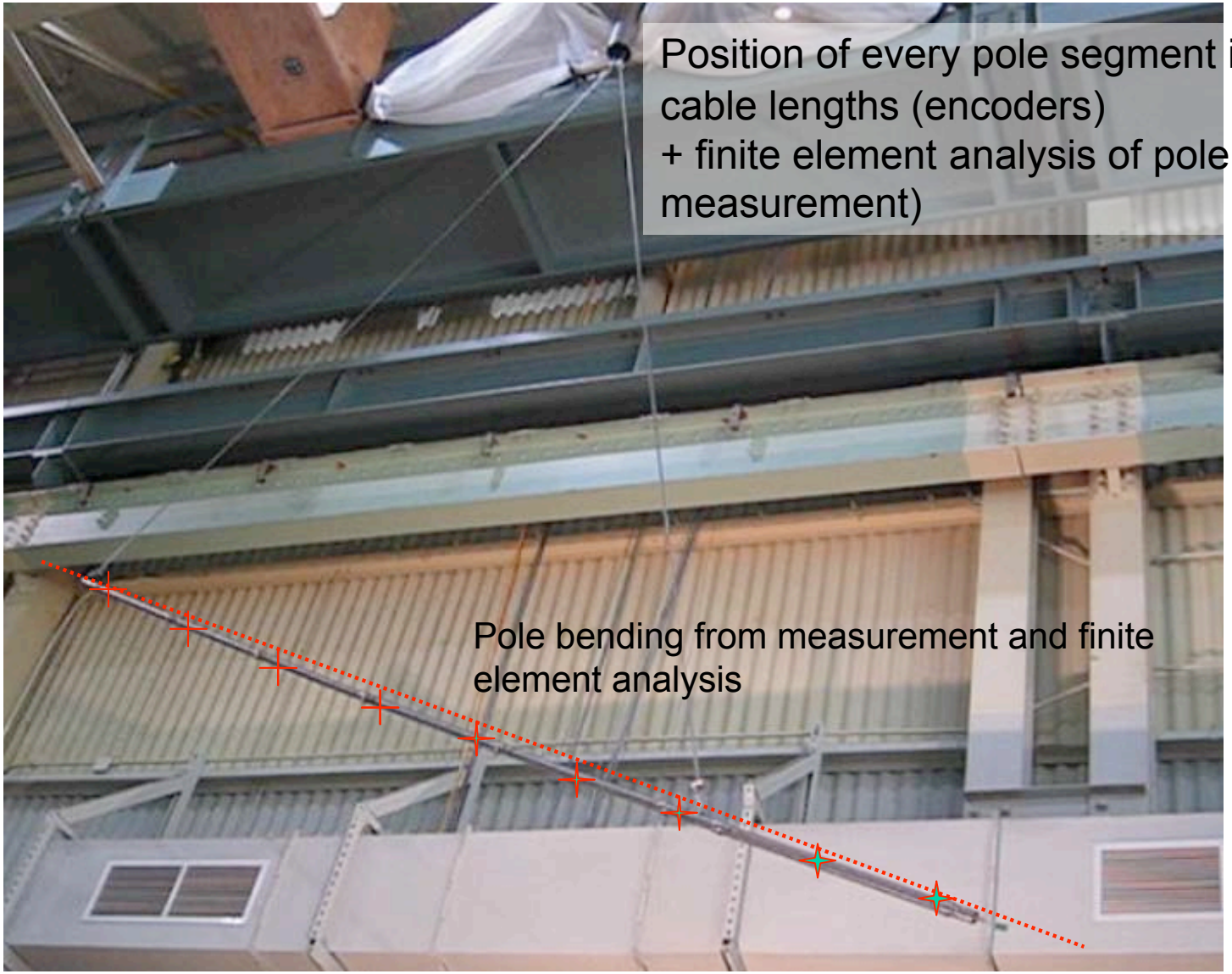
Multiple ^{60}Co source, primarily for vertex reconstruction


calibration in semicircles
duration: ~1 semicircle/shift
12 points = ~ 6-8hrs of data taking

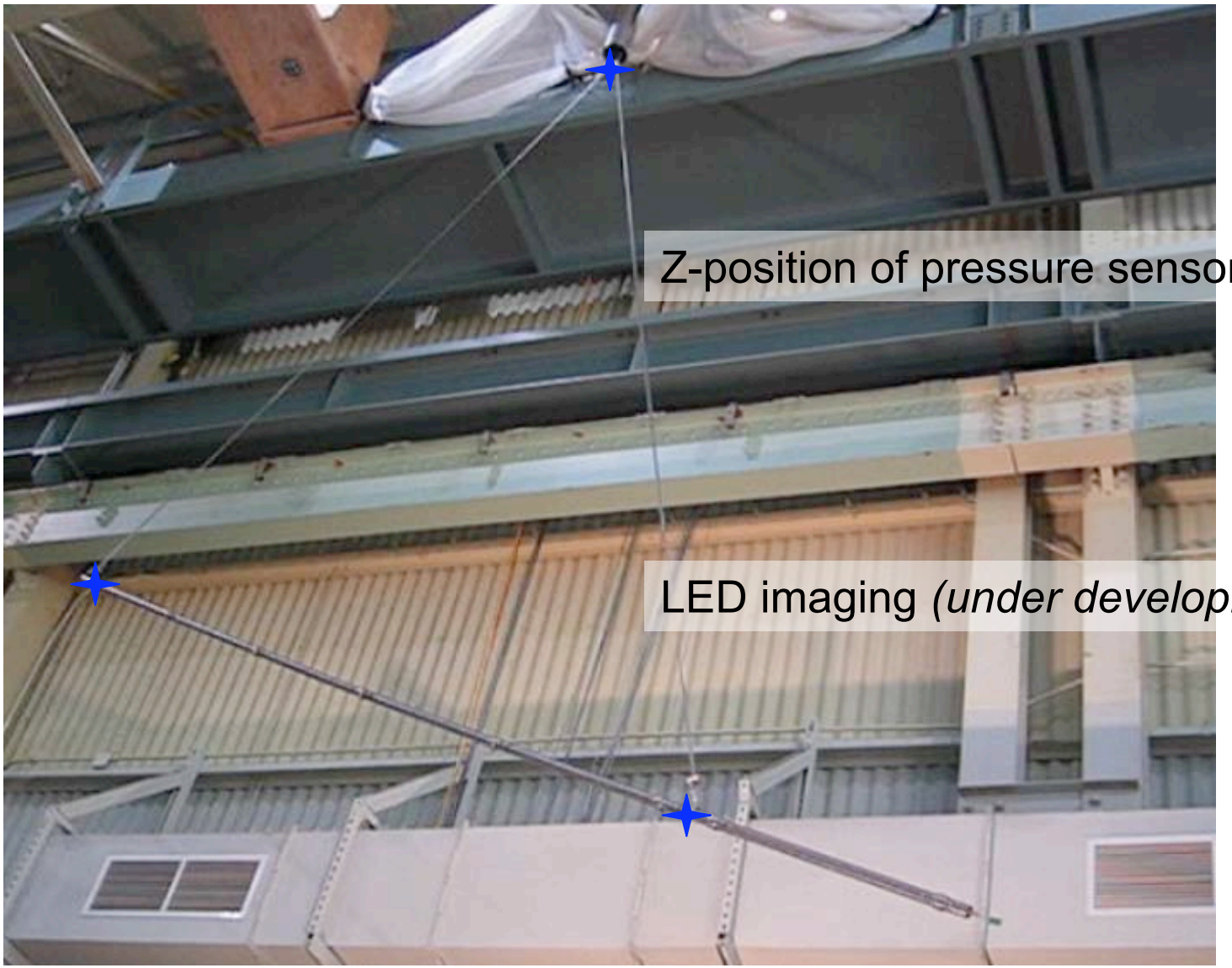
Radial Reach



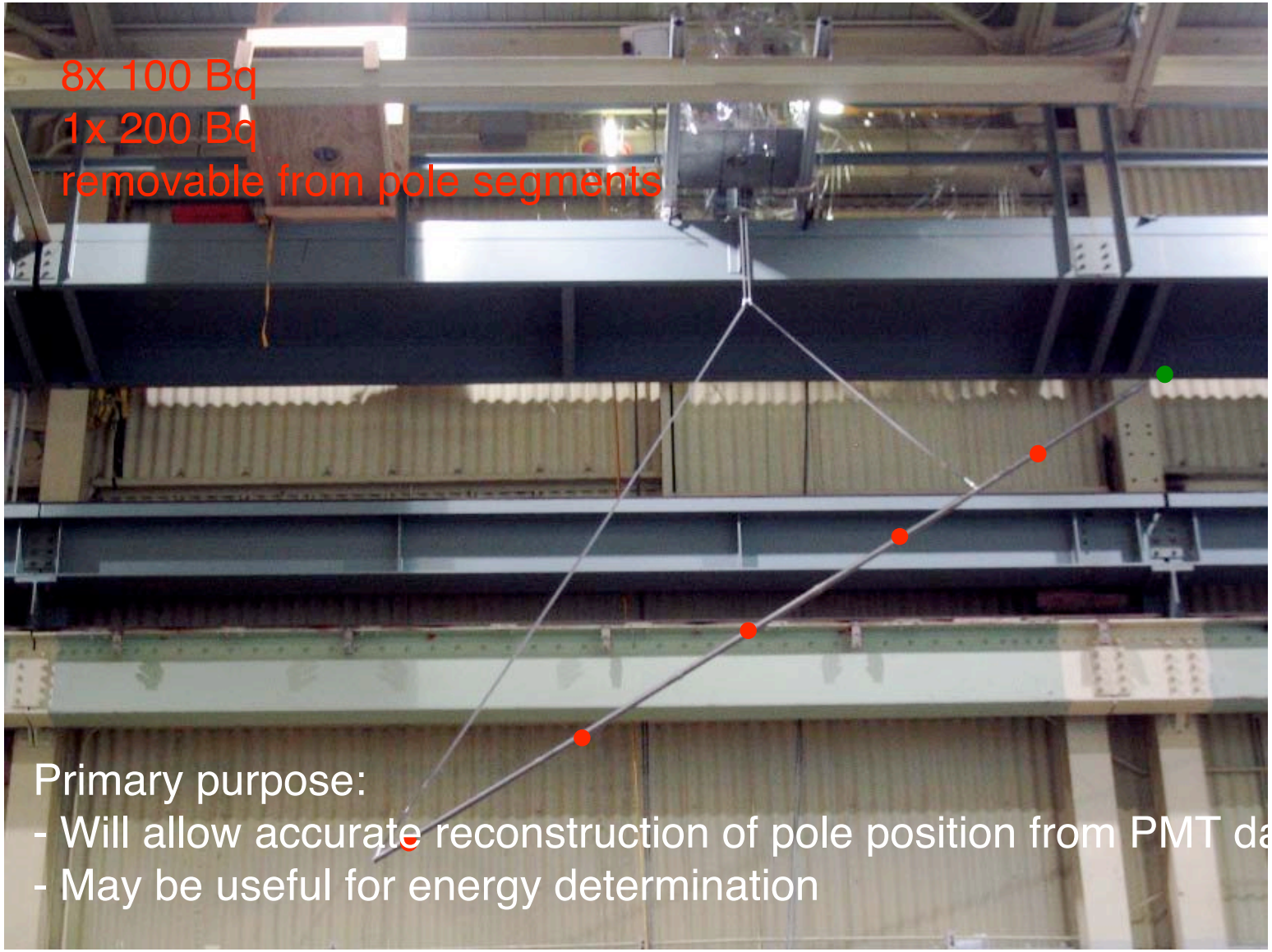
Position and Geometry Information



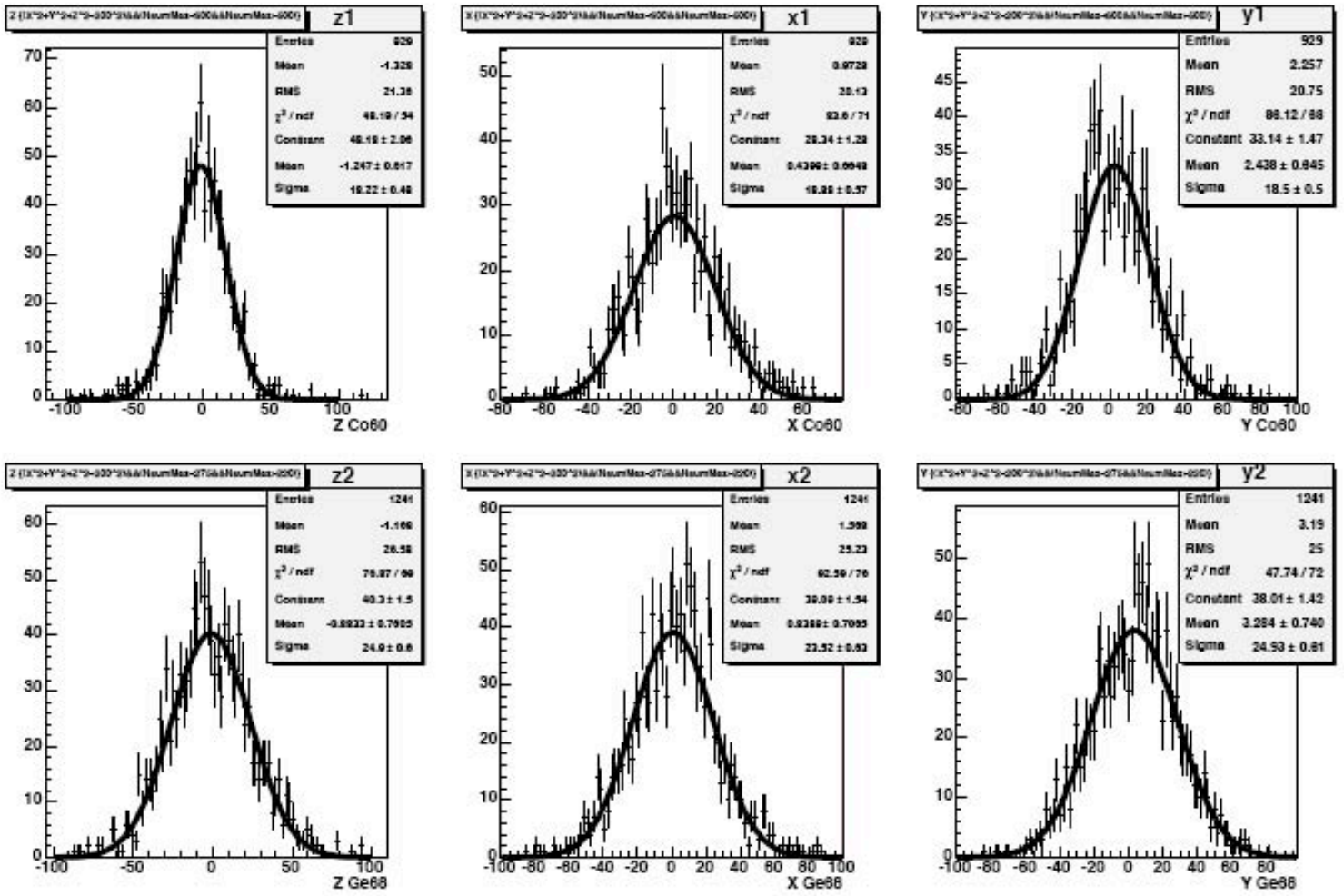
Position and Geometry Information



Removable ^{60}Co Sources in Every Pole Segment



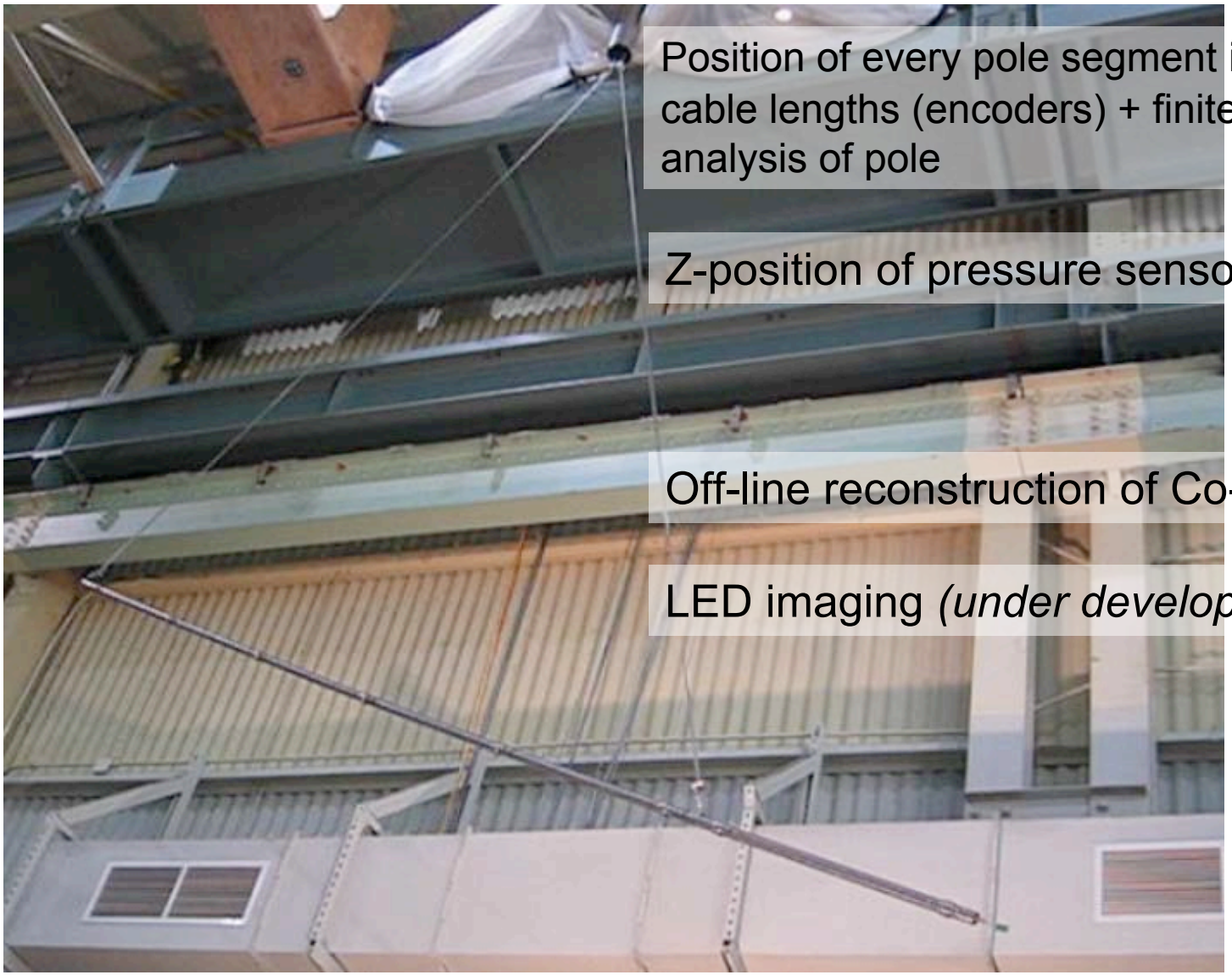
Offline Reconstruction of 60Co Sources



T. Classen

Figure 1: run 4398 position reconstruction, approximately 1000 Co-60 events

Determination of Source Position

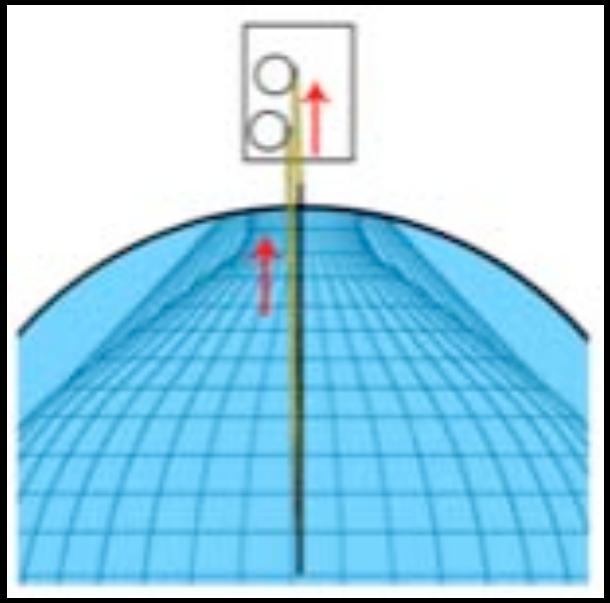


Position of every pole segment in $(r,\theta,\phi)$from cable lengths (encoders) + finite element analysis of pole

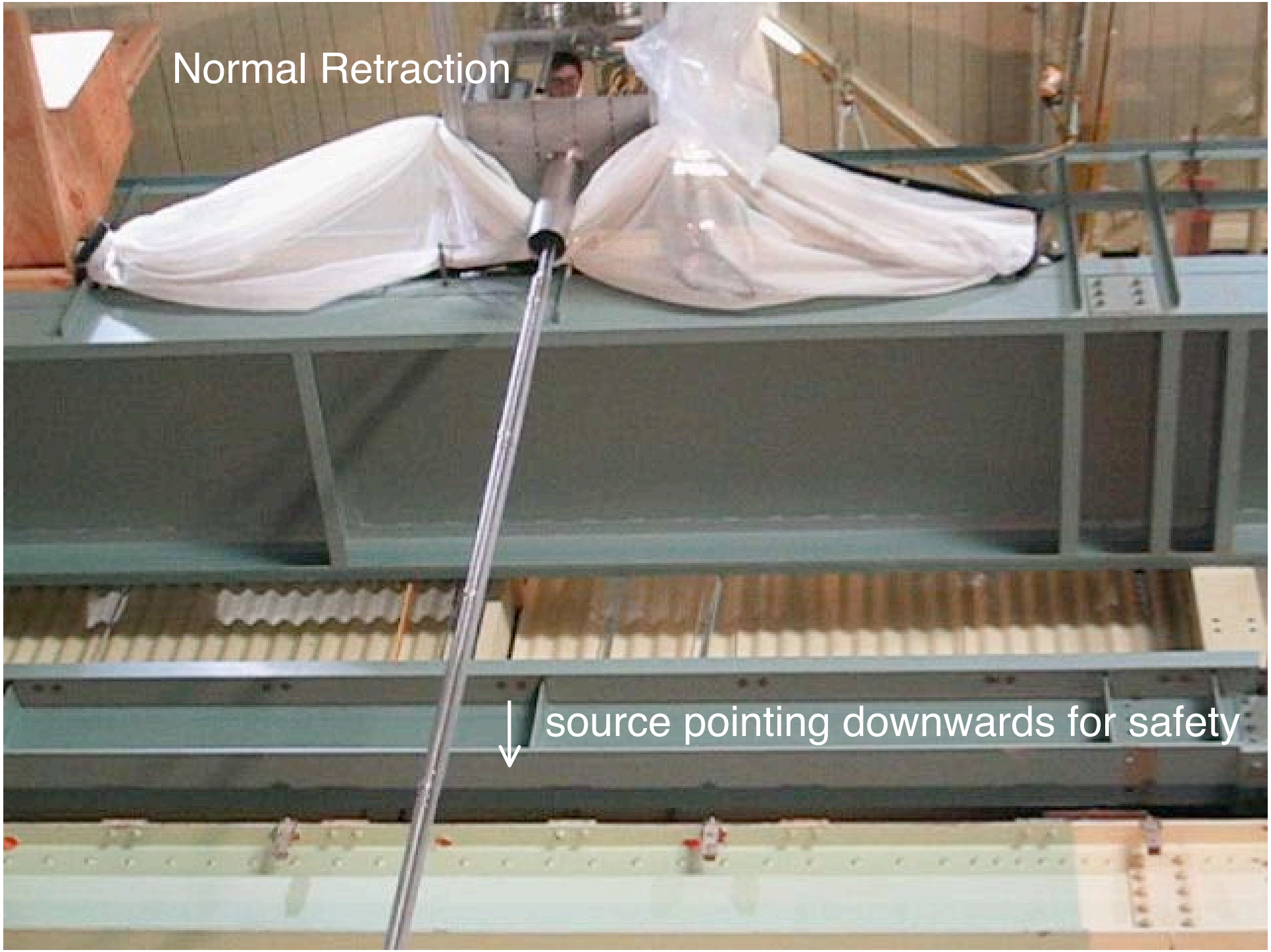
Z-position of pressure sensors

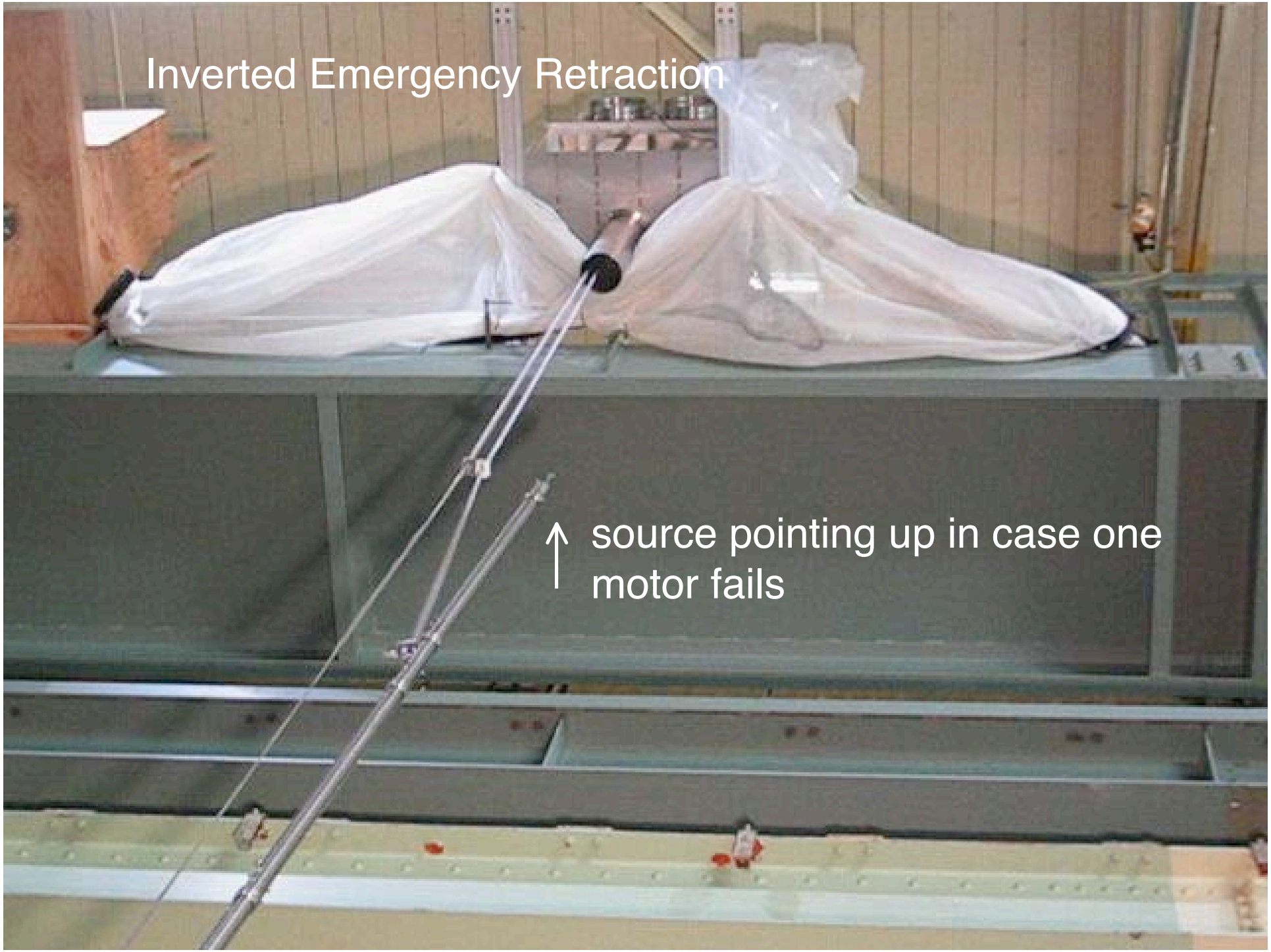
Off-line reconstruction of Co-60 sources

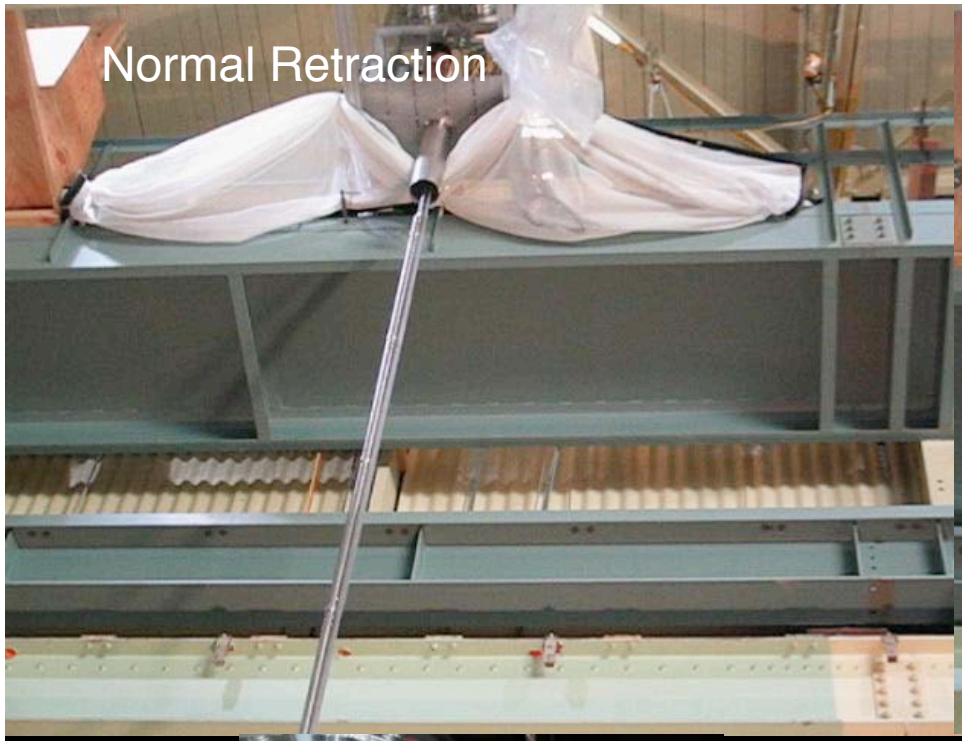
LED imaging *(under development)*

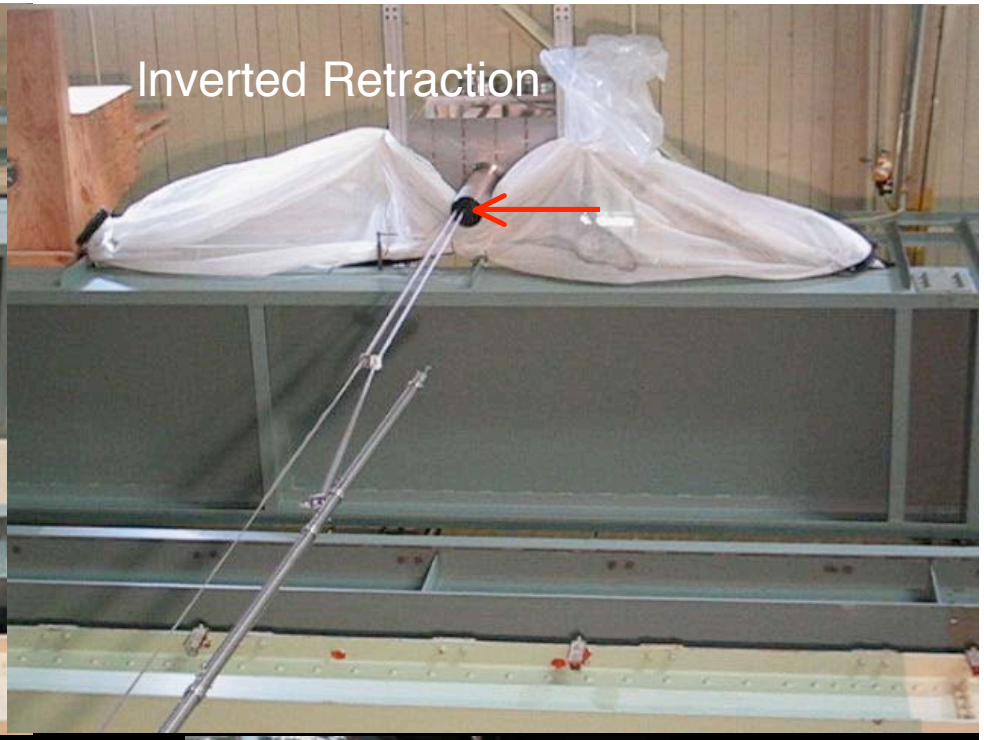


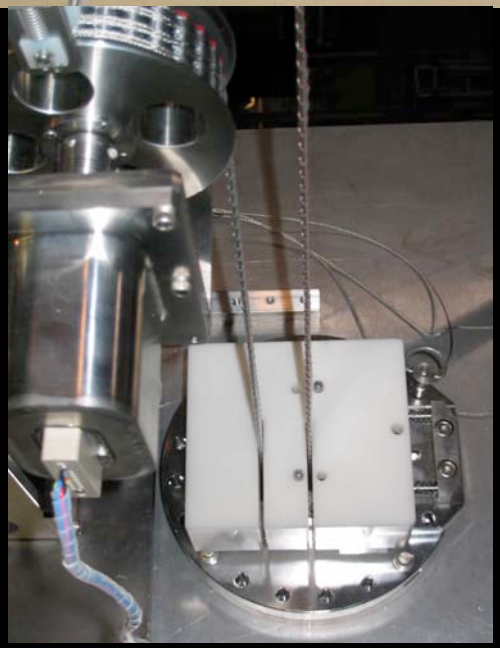
Retraction

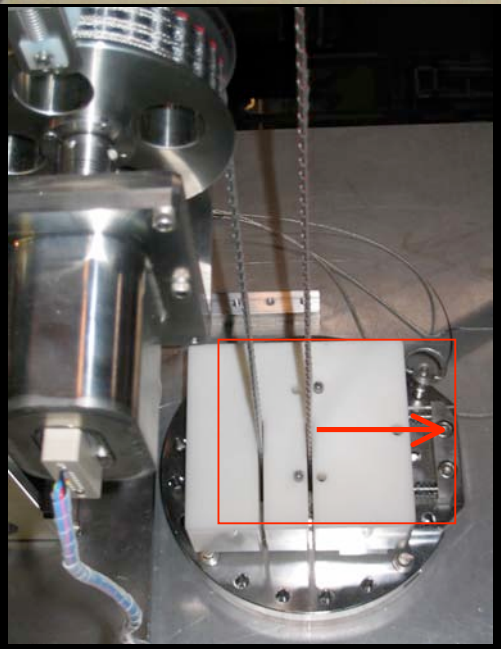

Normal Retraction
source pointing downwards for safety


Inverted Emergency Retraction
source pointing up in case one motor fails


Normal Retraction


Inverted Retraction

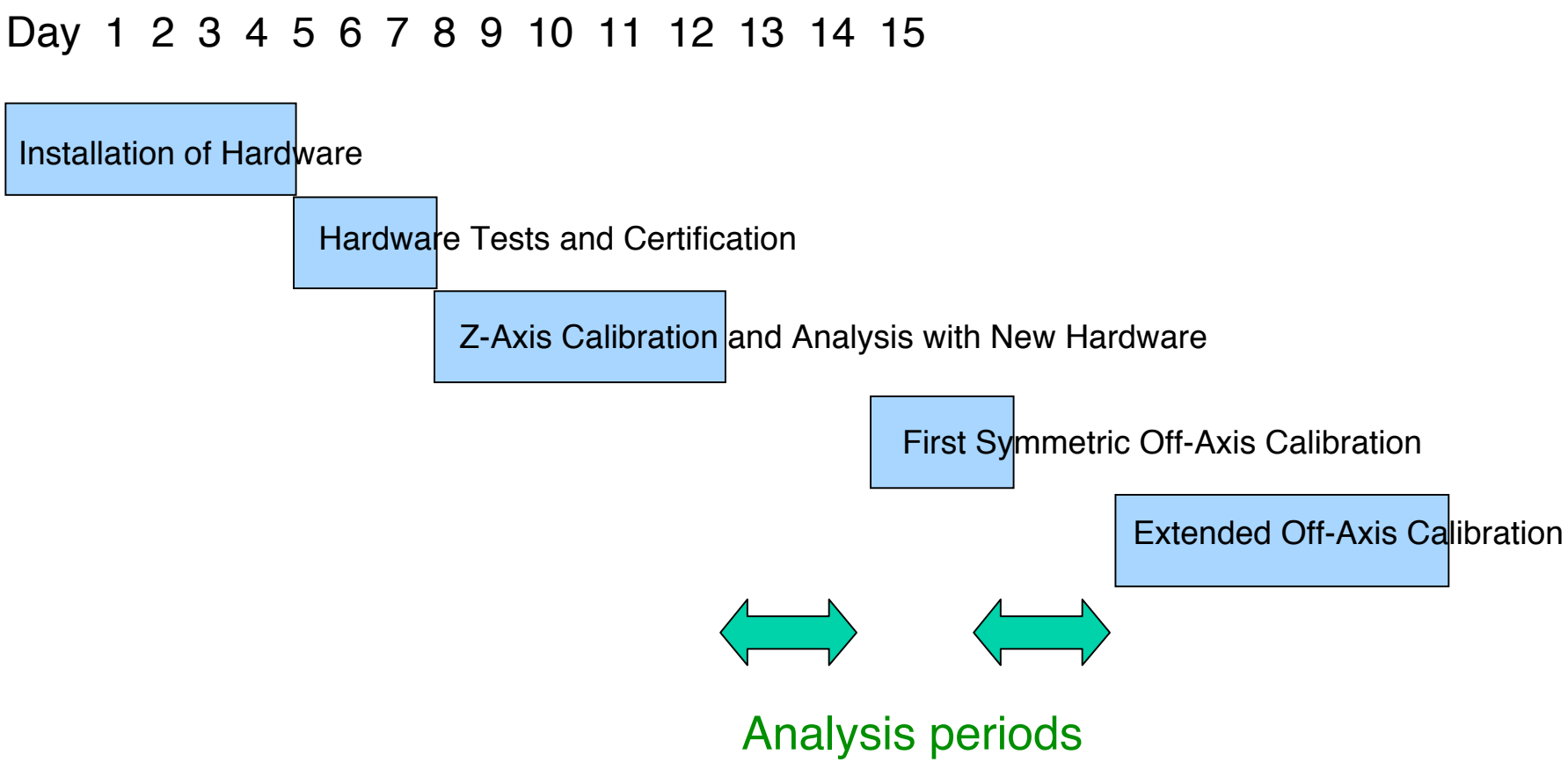





Inverted Emergency Retraction
Shift load
cable to left


Inverted Retraction

Commissioning Plan



Scheduling Considerations

April 30	completion of system at LBNL including mechanical testing
May 3-6	workshop and review at LBNL
May 8-9	disassembly of system
May 10-15	UHV cleaning
May 16-June 5	soak testing of cable and background counting on site
May 15-20	pre-assembly of deployment hardware at LBNL
May 20-28	shipment to Japan
May 28-June 5	receiving and preparation on site
June 5	start of 4pi installation